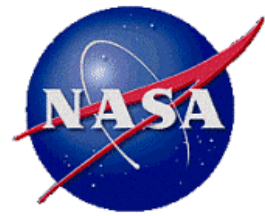




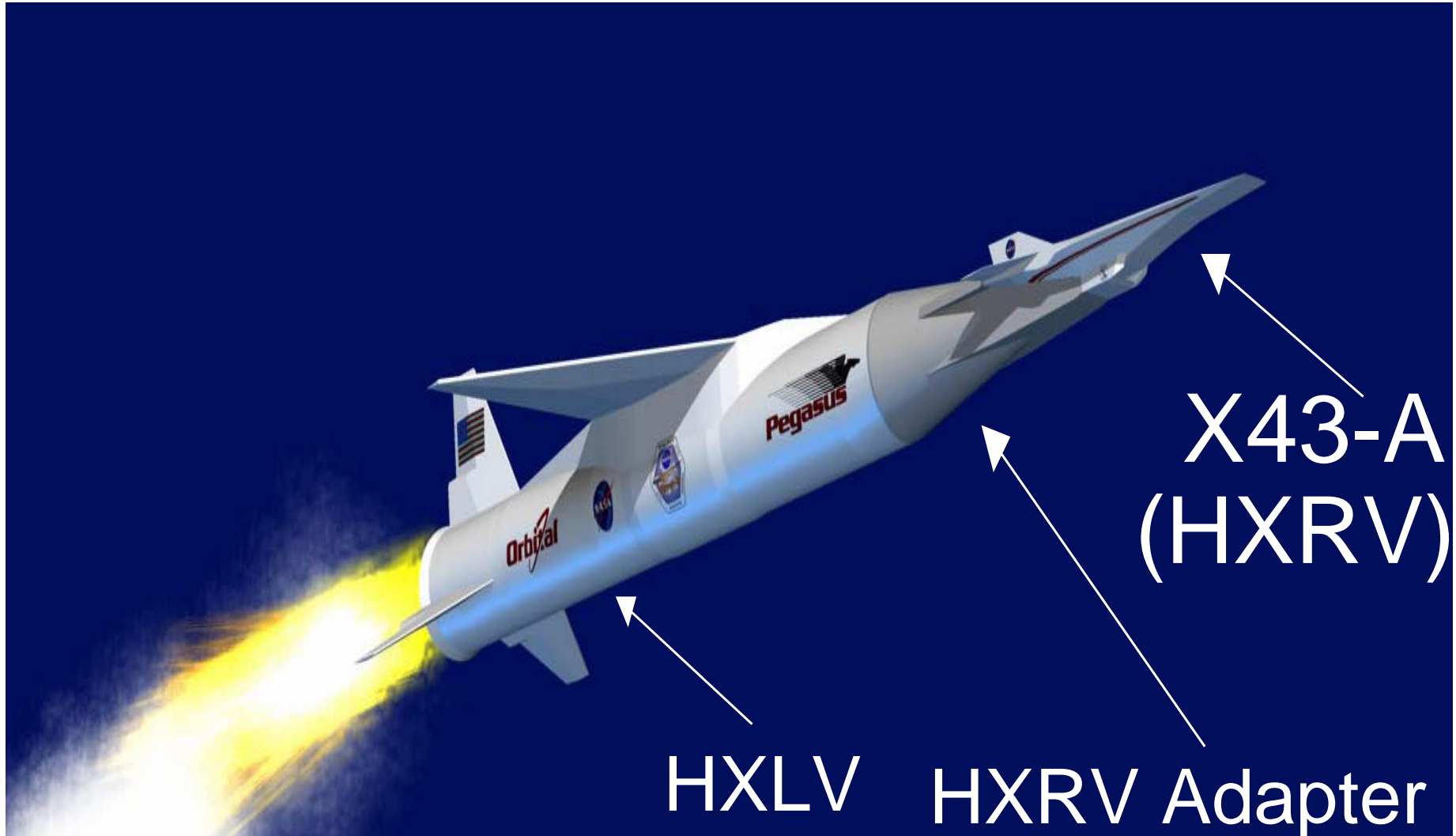
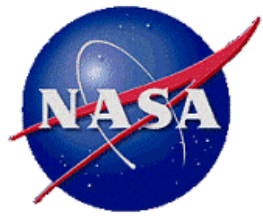
X43A Risk Management at Mach 7



Presented by
Lawrence Davis
Dryden Flight Research Center
Safety and Mission Assurance Director
with special thanks to
Langley Research Center SMA

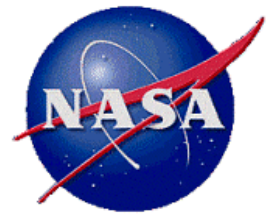


X-43A “STACK”





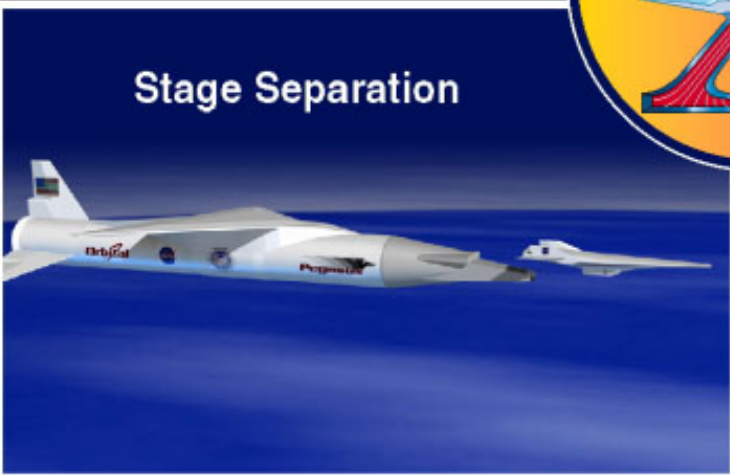
Key Mission Events



B-52 Captive Carry



Pegasus Boost



Stage Separation

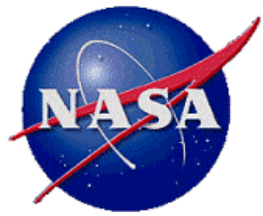


Scramjet Engine Operation



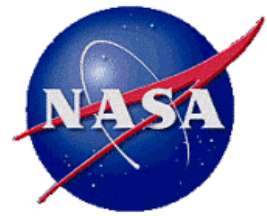


FLIGHT 1 MISHAP



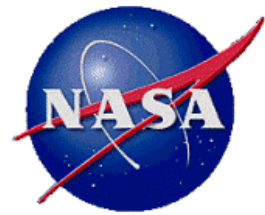


MIB DETERMINATION





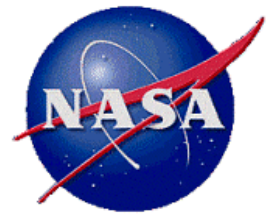
MISHAP INVESTIGATION



- **No single factor or potential contributing factor caused the mishap.**
- **The control system design was deficient in several analytical modeling areas, which overestimated the system's margins.**
 - **Major contributors to the mishap were**
 - **modeling inaccuracies in the fin actuation system and in aerodynamics, and**
 - **insufficient variations of modeling parameters.**

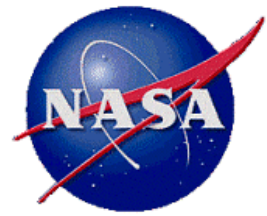


RETURN to FLIGHT



Hyper-X Vehicle 2





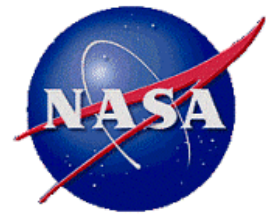
SMA Activities

Risk Management



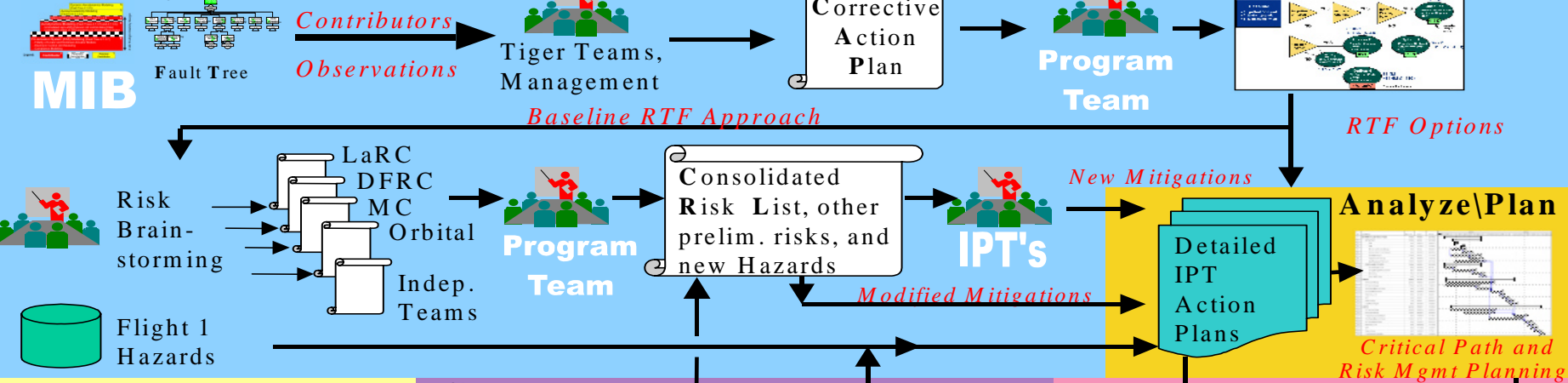


RETURN to FLIGHT SMA Activities

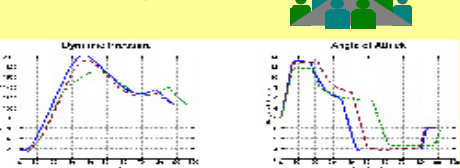


X-43A Continuous Risk Management Process

Identify



Analysis



Peer Assessment

Independent Simulation and Analysis

Control

Critical Decision Comparisons



Communicate

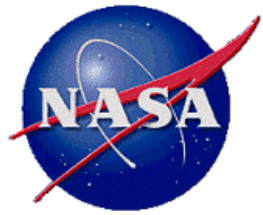


Track





SMA Activities



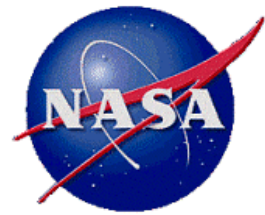
Fault Tree Analysis (FTA)

Failure Mode Effects Analysis (FMEA)

Verification and Validation Analysis
(Independent Center Analysis)



SMA Activities



Corrective Action Plan (CAP) example

9.3.1.3.1

MIB Findings/Recommendations

There was an error in the calculation of the ...

Corrective Action

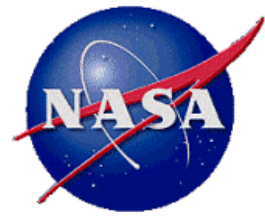
The identified ... errors have been corrected.

Documentation

- (1) Contractor Document ME034-179 Rev I, ...
- (2) MIB Closeout for Fault Tree Number 4.1.3.4.1, ...
- (3) MIB Closeout for Fault Tree Number 4.1.3.4, ...



SMA Activities







Hazard Analysis

Methodology

-  Human Safety
-  Mission Success

Risk Management Process

-  The Risk Management Board
-  Identify risks in the Consolidated Risk List (CRL)
-  Risk Closure
-  Hazard Reports capturing risks

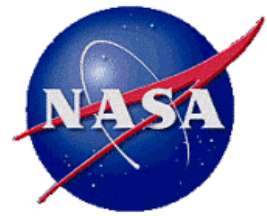
Documentation Database

-  Monitoring, tracking, and reporting



SMA Activities

Hazard Analysis

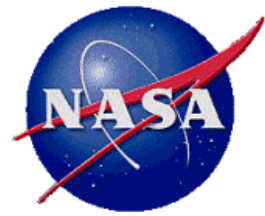


Hazard Action Matrix All Phases (Phases 1-7)

Hazard severity	Probability				
	A: LIKELY TO OCCUR FREQUENTLY	B: LIKELY TO OCCUR SEVERAL TIMES IN LIFE OF PROGRAM	C: LIKELY TO OCCUR AT SOMETIME DURING PROGRAM	D: UNLIKELY BUT POSSIBLE TO OCCUR	E: EXTREMELY IMPROBABLE
CATEGORY I DEATH					63
CATEGORY II LOSS OF HXRV PRIOR TO ENGINE DATA/LOST TIME INJURY			2	4	31
CATEGORY III HXRV DAMAGE-RTB				2	7
CATEGORY IV MISSION ABORT-RTB (Cost or Schedule Impact)				2	2



SMA Activities



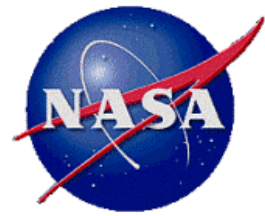
Quality Assurance

- ✍ Monitored vendor/project Quality system for vehicle production and test through on-site visits
- ✍ Monitored qualification, acceptance & functional tests for the HXLV and the HXRV
 - ✍ Fuel system blowdown and Aircraft-in-the-loop (AIL) validation testing on the RV
 - ✍ LV and RV flight software qualification, real time mission simulations are conducted formally in the presence of quality representatives on the flight computer hardware
- ✍ Performed compliance audit two weeks prior to Flight Readiness Review
- ✍ Reviewed all deliverable documentation
 - ☞ DD 250's



SMA Activities

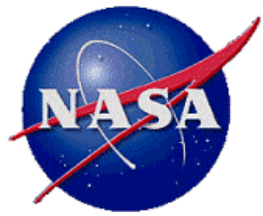
Additional Activities



- ✍ OSMA actively involved in project Meetings
 - ✍ Engineering Review Boards (ERB)
 - ✍ Risk Management Boards (RMB)
 - ✍ Government Propellant Offload Team Telecons/observed onsite
 - ✍ Integrated Product Teams (IPTs) meetings/telecons
 - ✍ Configuration Control Boards
 - ✍ Technical Interchange Meetings
 - ✍ Electronic Control Unit team
- ✍ Played key roles in PDR/CDRs
 - ✍ Flight Readiness Review (Independent Peers)
 - ✍ Airworthiness Flight Safety Review Board (Senior Management)
 - ✍ Integrated Mission Assurance Review (HQ OSMA)
 - ✍ Aeronautics Mission Directorate Review
 - ✍ Technical Brief (Senior Management)



SMA Activities



Range Safety

- ✍️ Coordinate with Range Safety to insure Dryden and Point Mugu considerations and required documentation had been satisfied

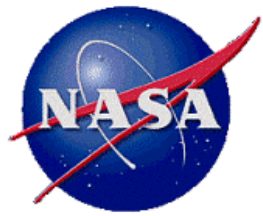
Mishap Contingency

- ✍️ Follow Mishap Plan for X43A
 - ☞ Mishap Plan identifies NASA roles & responsibilities for mishap and close calls
 - ☞ Identifies launch mishap notification responsibilities



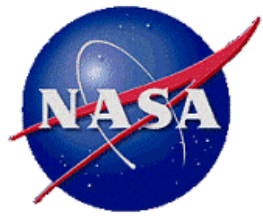
Training

Vehicle Preparation / High Pressure



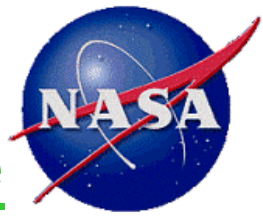


Training Control Room





SMA Activities



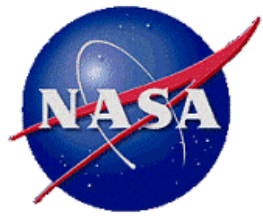
X-43A Integration to Launch Vehicle





SMA Activities

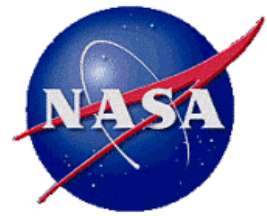
Launch Operations





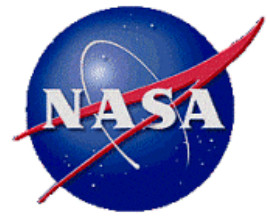
SMA Activities

Post Launch Activities





Mach 10 Approval Given



- **Flight Readiness Review**
- **Airworthiness and Flight Safety Review Board**
- **Integrated Mission Assurance Review**
- **Aeronautics Mission Director**